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BETWEEN SCORCHING HEAT AND FREEZING COLD: MEDIEVAL JEWISH AUTHORS ON THE INHABITED AND UNINHABITED PARTS OF THE EARTH*

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I. INTRODUCTION

How far away can one live on the earth? Is the southern hemisphere habitable and why are certain regions of the earth more suitable for habitation than others? In classical antiquity as well as during the Middle Ages, geographers, historians and philosophers have pondered these and other questions about the habitability of the earth and the boundaries of the inhabited world. Views on the *oikoumene* held by Greek authors and by the medieval Muslim sages who drew on classical sources have been studied in various contexts.[1] Comparatively little attention has been paid, however, to the treatment of this subject by medieval Jewish authors who, in turn, used Arabic sources in their writings. This paper seeks to fill part of this gap by examining the reception in some medieval Hebrew scientific texts of the views on the earth's habitability and the boundaries of the *oikoumene* as found in Arabic sources. My discussion will be limited to those twelfth- and thirteenth-century texts that present a more or less systematic treatment of this theme, namely Abraham

* This article is an expanded version of a paper presented at the 5th Congress of the European Association for Jewish Studies (Copenhagen, 14-18 Aug. 1994). I hereby wish to thank the *ASP* anonymous reviewers of this article for their valuable and careful comments.

[1] Cf. James S. Romm, *The Edges of the Earth in Ancient Thought. Geography, Exploration, and Fiction* (Princeton, 1992); G. Aujac, *Claude Ptolémée, astronome, astrologue, géographe. Connaissance et représentation du monde habité* (Paris, 1993); E. Honigmann, *Die Sieben Klimata und die πόλεις ἐπίσημοι* (Heidelberg, 1929). A wealth of material can also be found in J.B. Harley and D. Woodward, *Cartography in Prehistoric, Ancient and Medieval Europe and the Mediterranean*. The History of Cartography I (Chicago and London, 1987) and in *id.*, *Cartography in the Traditional Islamic and South Asian Societies*. The History of Cartography II (Chicago and London, 1992). For medieval Latin authors, see R. Simek, *Erde und Kosmos im Mittelalter* (München, 1992).

bar Ḥiyya's *Sefer Ẓurat ha-Areẓ* and *Sefer ha-'Ibbur*; Samuel ibn Tibbon's Hebrew translation of Aristotle's *Meteorology*, (the *Otot ha-Shamayim*), and the three thirteenth-century Hebrew encyclopedias of science and philosophy: Judah ben Solomon ha-Cohen's *Midrash ha-Ḥokhmah*; Shemtov ibn Falaquera's *De'ot ha-Filosofim* and Gershom ben Solomon's *Sha'ar ha-Shamayim*.[2] Of these, special attention will be given to the *Midrash ha-Ḥokhmah*, since this text addresses various issues related to the question of the earth's habitability.

As we shall see in more detail below, the aforementioned Hebrew authors essentially used two models in their descriptions of the earth's habitability, the first of which divided the *oikoumene* into seven climes, while the second divided the whole earth into five zones. Both theories are of Greek origin.[3] Therefore, it would be useful, by way of introduction, to review the classical theories and their transmission into Arabic science.

II. THE SEVEN-CLIMES THEORY AND THE FIVE-ZONES THEORY

2.1. *The seven-climes theory*

Deriving from the Greek *klima* (inclination), a 'clime' was originally a mathematical-astronomical concept that denoted 'the inclination of the plane of the local horizon to the earth's axis.'[4] In other words, a clime is a strip of land in all parts of which the angle between the sunrays that fall on the earth and the horizon is the same. In a geographical context, however, a clime came to denote a small latidudinal band stretching from east to west and included between two parallels. In the system that became standard, seven such horizontal belts were distinguished, constituting the inhabited part of the world. Each band

[2] This implies that I will not deal with texts that contain only isolated statements on the boundaries of the *oikoumene*. For Abraham ibn Ezra's views on the inhabited parts of the earth see S. Sela, *Abraham Ibn Ezra. Astrology and Biblical Exegesis* (Hebr.), Bar-Ilan Univ. Press (forthcoming).

[3] According to Romm, *Edges of the Earth*, p. 37 Herodotus was the first to use the term *oikoumene*.

[4] I. G. Kidd, *Posidonius. II. The Commentary*; *(ii) Fragments 150-293* (Cambridge etc., 1988), p. 737. Cf. also O. Neugebauer, *A History of Ancient Mathematical Astronomy*, 3 vols., Studies in the History of Mathematics and Physical Sciences (Berlin and New York, 1975), I, 333ff; II, 725 ff; Honigmann, *Sieben Klimata*, pp. 4-7.

differed from the next as regards the length of the longest day in summer by half an hour in its centre. In the centre of the first and most southern clime, the longest day lasted 13 hours; in that of the second 13 and a half and so on until the seventh and most northern clime where the longest day lasted 16 hours.

Although it is generally agreed that the seven-climes theory is of Greek origin, it is very difficult to assign this notion to a particular author with any certainty. Reinhardt's thesis that it originated with Posidonius (c. 135-50) has been challenged by Honigmann and, more recently, by Kidd.[5] Nor can it be proved that any of the other thinkers that have been put forward as possible candidates, Hipparchos (c. 190-c. 125) or Eratosthenes (c. 275-194), can be credited with the origin of this theory.[6]

It should be emphasized that various sets of climes were used by classical authors,[7] and sometimes even by one author, as is shown by Ptolemy's works. In his astronomical magnum opus, the *Almagest*, in which he sought to establish 'the position of the inhabited world on the terrestrial globe, and its relation to the celestial sphere, together with the distribution of the climata',[8] Ptolemy dealt with the question of the boundaries of the inhabited world several times. However, he does not seem to have settled on one particular conception of the division of the inhabited world, since the work reveals various schemes of the *oikoumene*, that of the seven climes being only one. In *Almagest* II.6, Ptolemy distinguishes 33 parallels from the equator up to a latitude of approximately 66 1/6° north where the longest day is 24 equinoctial hours, whereas in II.8 he lists eleven climes.[9] In *Almagest* II.12-13, we find a reference to a list of seven climes that closely corresponds to the aforementioned classical standard model. According to Neugebauer, Ptolemy took this more or less canonical model for granted in the arrangement of several of his tables.[10]

[5] K. Reinhardt, *Kosmos und Sympathie, neue Untersuchungen über Poseidonios* (München, 1926), pp. 56 ff, 398-400; Honigmann, *Sieben Klimata*, pp. 8-21; Kidd, *Posidonius*, II (ii), pp. 736-8.

[6] This lack of clarity seems to go back to Strabo, see Honigmann, *Sieben Klimata*, pp. 10-24 and see also Neugebauer, *Ancient Mathematical Astronomy*, I, 334.

[7] Cf. Kidd, *Posidonius*, II (ii), 737-8: "The evidence shows that a variety of Sevens and a variety of variously numbered sets co-existed."

[8] Harley and Woodward, *Cartography*, I, 182.

[9] *Ibid*., pp. 182-3.

[10] Neugebauer, *Ancient Mathematical Astronomy*, II, 726.

Regarding the more general question of the boundaries of the inhabited world, Ptolemy also seems to have held a variety of views.[11] In the *Almagest*, Ptolemy, although referring to the hypothesis of inhabited land along the equator, subscribed to the traditional idea that the inhabited world was to be situated north of the equator, on the grounds that we have no reliable information regarding habitation south of it.[12] In the *Tetrabiblos*, too, habitation is confined to the northern hemisphere.[13] However, in his later work, the *Geography*, Ptolemy held the parallel opposite the one through Meroë, that is the one at 16˚25´ south, to be the southern limit of the *oikoumene* and the parallel passing through Thule at a latitude of 63˚ north to be the northern one. Thus the total latitudinal distance of the inhabited world, according to the *Geography*, is 79˚25´.[14]

Ptolemy, then, was prepared to admit the theoretical possibility of inhabited land along the equator even though he did not arrive at a definitive answer.[15] According to Strabo, Polybius and Eratosthenes also defended the possibility of inhabited areas along the equator, but the geographer himself was of the opinion that more than half of the torrid zone was uninhabitable.[16] Posidonius went one step further and assumed that the equatorial zone was indeed populated. In advocating this view he based himself on two arguments, the first being that the sun does not tarry long above the equator but approaches it quickly and departs from it quickly, and the second being that in the equatorial zone the day lasts as long as the night, so that the air can be cooled sufficiently during the night. On these two grounds he considered the so-called torrid zone to be temperate and thus fit for habitation.[17]

As is the case with so many other Greek concepts, the idea of the seven climes found its way into Islamic science and culture. It was not only elaborated on in scholarly writings of astronomers

[11] For the development of Ptolemy's conception of the *oikoumene*, see Aujac, *Claude Ptolémée*, p. 39 ff. and especially pp. 111 ff.

[12] *Almagest* II.6.

[13] *Tetrabiblos* II.3.

[14] *Geography* 1.11.1 and 1.12.10.

[15] In *Almagest* II.6 Ptolemy states that there is no reliable information on habitation south of the equator. Cf. Aujac, *Claude Ptolémée*, pp. 111-12.

[16] Aujac, *Claude Ptolémée,* pp. 49-50, cf. *Geogr*., 2.2.2 and 2.3.2.

[17] Kidd, *Posidonius*, II (ii), 750-2 and *Posidonius*, II (i), 236-7. Kidd points out that classical authors did not agree as to the boundaries of the so-called torrid zone, cf. *ibid.*, 222-5. For Aristotle this zone coincided with that between the tropics.

and geographers, but it also became very popular in encyclopedical and *adab*-literature,[18] since a general knowledge of the configuration of the earth was considered to be essential for anyone who wished to be, or to appear, well-educated. The original relation of the theory to astronomy has been preserved in several of the classifications of the sciences, both in more popular and in philosophical writings. Al-Fārābī, for instance, classifies the question of the *oikoumene* and the climes as falling under the heading of mathematical astronomy, the other two parts of this science being, first, the forms, relations and distance of celestial bodies, and second, the motions of heavenly bodies.[19] However, Islamic geographers generally ignored this origin, using the theory solely as an organizing principle to give a detailed description of cities, mountains and rivers in each clime. Thus, in the course of time, the Arabic form of the term clime, *iqlīm*, lost its specific meaning and became the equivalent of 'region' or 'country'.[20]

Although it is difficult to determine through exactly which channels the theory of the seven climes reached the Arabs, it is certain that Ptolemy was highly influential in imparting the theory of the seven climes to Muslim scientists.[21] However, in view of the fact that Ptolemy referred to a variety of schemes relating to the *oikoumene* and given that in classical times several sets of climes were already circulating, it will come as no surprise that the writings of Muslim authors also display a variety of opinions. Muslim scholars generally agreed that the

[18] See for example Qazwīnī, who says that these climes are 'rolled out like carpets', *Kitāb 'aǧā'ib al-makhlūqāt*, ed. F. Wüstenfeld (Göttingen, 1849), vol. I, p. 147.

[19] Al-Fārābī, *Iḥṣā' al-'ulūm*, ed. A. Gonzales Palencia (Madrid, 1932), pp. 30-1. Ibn al-Akfānī also distinguished four parts of astronomy, the third being that of the *oikoumene*. See J.J. Witkam, *De Egyptische arts Ibn al-Akfānī (gest. 749/1348) en zijn indeling van de wetenschappen* (Leiden, 1985), p. 208 and Christel Hein, *Definition und Einteilung der Philosophie. Von der spätantiken Einleitungsliteratur zur arabischen Enzyklopädie* (Frankfurt a.M.- etc., 1985), p. 219.

[20] Honigmann underlines that the term had also been used in this sense in antiquity, *Sieben Klimata*, p. 6.

[21] Cf. Harley and Woodward, *Cartography,* II, 76: 'In its Ptolemaic version, the theory that the inhabited portion of the earth was divided into seven climata [...] rapidly became an inalienable part of Islamic high learning.' However, it is also possible that the related Persian notion of the seven *kishvars* has mingled with Greek views and thus has also been influential in the transmission of the climes-theory to Muslim scientists. The *kishvars* are circular regions, all having the same size, which constitute the habitable world in such a way that six of them are situated around the seventh, central one, cf. Harley and Woodward, *Cartography*, II, 8, 77-80 and 93-4.

seven climes were situated in the northern hemisphere. Some authors, however, were ready to admit that there were also seven climes south of the equator.[22] It was also commonly accepted that the climes were determined by the proportion of the longest to the shortest day so that each clime could be distinguished from the next by a difference of half an hour of daylight on the longest day of summer.

Opinions differed, however, with regard to the delineation of the climes and the boundaries of the habitable world. Several authors, such as al-Farghānī (fl. 861), al-Battānī (d. 929) and al-Bīrūnī (d. after 1050) situated the beginning of the first clime at a latitude of about 12° north and the limit of the seventh at about 50°,[23] whereas others, such as al-Khwārizmī (d. after 847) started at the equator and determined the end of the seventh clime at a latitude of 48° north.[24] Some authors, following Ptolemy's account of *Almagest* II.8, fixed the northern limit of the seventh clime at 48°, while admitting that beyond this limit habitation was still possible. Most scholars agreed that the latitude of 66° constituted the boundary of the inhabited world. Occasionally, one finds 63° as the limit, which is the figure given in Ptolemy's *Geography*, as we have seen above. Apparently al-Mas'ūdī, who refers to an otherwise unspecified work 'on the *oikoumene*' by Ptolemy, had this figure in mind when asserting that, according to Ptolemy, the *oikoumene* extended from 63° north to 16° south.[25]

2.2 *The five-zones theory*

The second theory on the earth's habitation to be found in medieval Jewish scientific writings is the five-zones theory. This theory divides the earth into three zones that are uninhabitable owing to extreme temperatures and two zones that are temperate and therefore inhabitable. The three zones that are unin-

[22] Cf. *Encyclopedia of Islam*, 2nd. ed., III, 1076 s.v. 'iḳlīm' (A. Miquel).

[23] Cf. the tables given in Honigmann, *Sieben Klimata*, p. 163 and cf. Harley and Woodward, *Cartography*, II, 102. For al-Bīrūnī, *Kitāb al-Tafhīm*, ed. R. Ramsay Wright (London, 1934), pp. 236-7.

[24] See E. Wiedemann, *Aufsätze zur arabischen Wissenschaftsgeschichte* (Hildesheim etc., 1970), vol. I, p. 787, n. 1.

[25] Cf. al-Mas'ūdī, *Kitāb al-Tanbīh wa al-ishrāf,* ed. M.J. de Goeje (Leiden, 1894), p. 25; trans. Carra de Vaux (Paris, 1896), pp. 41-2.

habitable are the two polar zones where extreme cold prevents human settlement and the equatorial zone where it is far too hot for habitation. The two moderate zones are situated between these zones of excessive heat and excessive cold, one in the northern and the other in the southern hemisphere.

This theory is also astronomical in origin, for these zones were determined by the shadow cast by the sun. According to Strabo, who may have followed Posidonius in this respect, the idea of the division into five zones originated with Parmenides,[26] but Thales and Pythagoras have also been mentioned in this connection.[27] In any event, Posidonius played an important role in its development by linking these originally astronomical zones to the zones of habitation.[28] Aristotle discussed the question of the *oikoumene* in his *Meteorology*, where it appears within the context of his treatment of winds. Without explicitly referring to a five-zone scheme, Aristotle distinguished between two zones that were fit for habitation due to their moderateness and three zones that were uninhabitable due to extreme temperatures: the zone beyond the tropics (the equatorial zone that is) and the lands beneath the Bear.[29] Aristotle also put forward the idea of a congruent habitable area in the western hemisphere, stating that it would be theoretically possible for the *oikoumene* to extend around the globe as far as the climate is concerned, but that the sea prevents the existence of another inhabited world in the West.[30]

As might be expected, this theory about the division of the *oikoumene* came to be adopted by Muslim scholars and philosophers who were influenced by Aristotle or treated the subject under consideration within an Aristotelian framework. The most important of them for our subject is Ibn Rushd, whose commentaries on Aristotle were extensively employed by some of the Hebrew encyclopedists of the thirteenth century. Therefore, a description of Ibn Rushd's discussions of the

[26] Kidd, *Posidonius,* II (i), 222, 224-5, and *id.*, II (ii), 748. Cf. Strabo, *Geography* 2.2.1.

[27] Kidd, *Posidonius*, II (ii), 748.

[28] *Ibid*., II (i) 230-1, 234, and II (ii), 742-7.

[29] *Meteor*. 362a33-362b12.

[30] *Meteor*. 362b14-30, cf. also *De Caelo* 298a10ff. Eratosthenes and Strabo, too, seem to have held this view, cf. Strabo, *Geography* 1.4.6. In Strabo's formulation the *oikoumene* formed a belt 'itself meeting itself', trans. H.L. Jones, *The Geography of Strabo* (Cambridge, Mass., 1960), p. 243.

earth's habitability will be provided (section V) before we proceed to deal with these Hebrew authors (sections VI-VII). At this point it is perhaps worth noting that the two notions of the inhabited world were often confounded[31] (as a result of which the terms 'climes' and zones' were sometimes used interchangeably), the common ground between them being a linkage of zones of temperatures with habitation.

III. ABRAHAM BAR ḤIYYA

We will now turn to the first Hebrew author to have systematically dealt with the question of the *oikoumene*, the astronomer, philosopher and mathematician Abraham bar Ḥiyya of Barcelona (d.c. 1136). This multifaceted scholar, who was the first to write about scientific subjects in Hebrew, wrote most of his treatises for the benefit of his coreligionists in Southern France and Northern Spain who had no access to scientific works written in Arabic. He discussed the habitability of the earth in both *Sefer Ẓurat ha-Areẓ* (The Shape of the Earth) and *Sefer ha-'Ibbur* (Book on Intercalation). The *Sefer Ẓurat ha-Areẓ* (hereafter abbreviated as *ẒA*), which may be described as a manual on cosmography, is the first part of a bipartite work that aims to systematically expound Ptolemaic astronomy in Hebrew.[32] The *Sefer ha-'Ibbur* (hereafter abbreviated as *SI*), which is presumably earlier than the *ẒA*[33] explains how to calculate the Islamic and Jewish years.

Although there are some discrepancies with regard to the figures given in these works (cf. below), both accounts basically yield the same picture of the inhabited world. Their starting point is that one can divide the world into four quarters with the help of two imaginary lines, i.e., the equator, which divides

[31] Honigmann, *Sieben Klimata*, p. 19ff and A. Altmann, 'The climatological factor in Yehudah Halevi's theory of prophecy' (Hebr.), *Melilah*, 1 (1944): 1-17, pp. 3-4.

[32] The entire work is known under the title *Ḥokhmat ha-Ḥizayon we-Tavnit Kaddurei ha-Raqi'a,* the title of the second part being *Ḥeshbon Mahalkhot ha-Kokhavim*. However, according to Millás Vallicrosa, who translated the Hebrew treatise into Spanish, the *Zurat ha-Areẓ* constitutes the astronomical part of Abraham bar Ḥiyya's encyclopedic work *Yesodei ha-Tevunah*, of which only a small part is extant, J.M. Millás Vallicrosa, *La obra forma de la tierra de R. Abraham bar Ḥiyya ha-Bargeloni* (Madrid-Barcelona, 1956), p. [11].

[33] According to its editor, it was written in 1122, cf. H. Filipowski (London, 1851: intr. p. vii). Cf. also Millás Vallicrosa, *La obra forma*, p. 45, n. 25.

the earth latitudinally, and a line through the north and south poles, which divides the earth longitudinally. In both works, Abraham bar Ḥiyya states that half of the earth consists of water and the other half of dry land. However, not all of the dry land is suitable for habitation. In fact, habitation is confined to an area that stretches from 66° north to 16° south. Further north, habitation is impossible due to extreme cold, whereas the southern hemisphere from the latitude of 16° onwards is too hot to be habitable.[34]

Regarding the inhabited part of the southern hemisphere, Bar Ḥiyya observes in the *SI* that this area 'is inhabited by the sons of Ham who have been cursed by Scripture' and that their way of life in every respect differs from that of the peoples of the north, which is why scholars have not felt themselves inclined to deal with these people.[35] This remark is absent from the *ẒA* where Bar Ḥiyya merely states that scholars, having found no evidence of habitation beyond the latitude of 16° south, concluded that there was no habitation in that region on account of the extreme heat there. Thus the inhabited portion of the earth stretches over a latitude of 82°, and a longitudinal distance of 180°.

Furthermore, the two works assert that the known habitable world, which is to be situated on the northern hemisphere, is divided into seven climes. In both works, Bar Ḥiyya gives an enumeration of the seven climes, specifying for each the relation of the longest to the shortest day as well as the parallels between which it is situated. The *ẒA* gives a more complete account by adding the names of the cities and regions found in the various climes. To give an example, in the first clime, which stretches from the equator until a latitude of 16°30' north, the longest day lasts 13 hours and the shortest day 11. It comprises the springs of the Nile, Saba, the countries of the Hamites, the Cushites and the Berbers. The seventh and last clime, in which the longest day lasts 16 hours and the shortest eight, stretches from 48° to 66° and comprises, among others, the isles of Great Britain ('Britannia Rabba').[36] In both works, this division of the

[34] *ẒA*, ed. M. Jaffe and Jonathan b. Joseph (Offenbach, 1720), 7^{r}; *SI,* p. 6-7. A more elaborate account of this theory can be found in various Arabic works. See, for example Y.T. Langermann, *Ibn al-Haytham's On the Configuration of the Earth* (New York, 1990), chapters 3-4.

[35] *SI,* p. 7.

[36] *ẒA*, 7^{r-v}.

oikoumene into seven climes is illustrated by a diagram, consisting of a circle that represents the earth and nine straight lines, the first of them being the equator and the remaining eight the boundaries of the various climes (see Fig. 1, below).

It is clear that the ultimate source from which his exposition derives is Ptolemy. What is less clear, however, is whether he quoted Ptolemy directly or followed the words of one of the Arab astronomers. In his *SI* Abraham bar Ḥiyya situated the climes between the latitudes of 12° and 54°, allotting each of them a latitude of 6°.[37] Honigmann's assumption that Bar Ḥiyya here drew on al-Idrīsī has been challenged by Uhden on the grounds that al-Idrīsī's map dates from 1154, Bar Ḥiyya having died in 1136.[38]

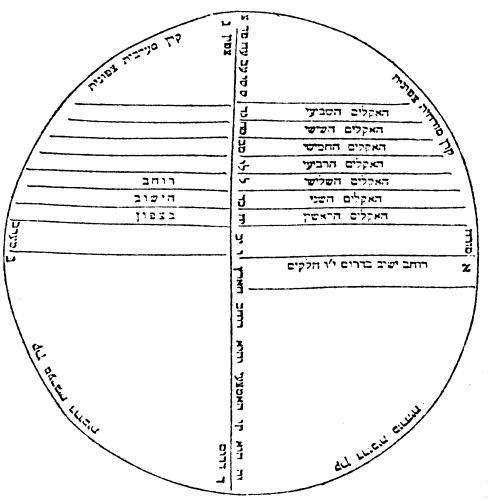

Fig. 1
The seven climes, according to Abraham bar Hiyya, *Sefer ha-'Ibbur,* ed. H. Filipowski (London, 1851), 8. (By permission of the Bibliotheca Rosenthaliana, Amsterdam)

[37] These figures correspond to Strabo's delineation of the inhabited world (*Geogr.* 2.5.8). However, for Bar Ḥiyya they constitute the limits of the climes, the boundaries of the *oikoumene* still being the latitudes of 16 degrees south and 66 degrees north, as has been stated above.

[38] Honigmann, *Sieben Klimata*, p. 184; R. Uhden, 'Das Erdbild in der Tetrabiblos des Ptolemaios', *Philologus,* 88 (1933): 278-391, p. 324. It should be noted, however, that it is not certain that Bar Ḥiyya died in 1136. This has been deduced from the fact that after 1136 Abraham bar Ḥiyya is mentioned no longer as a co-translator by Plato of Tivoli.

The *ẒA* yields a different picture. Millás Vallicrosa insists that in this work Bar Ḥiyya's principal source was al-Farghānī (to whom Bar Ḥiyya refers along with Ptolemy and al-Battānī), on account of the many similarities in their enumeration of the regions comprised by the various climes.[39] This may well be true, but there are also some noticeable differences. To begin with, Bar Ḥiyya situated the beginning of the first clime at the equator, contrary to his alleged source (cf. above). Furthermore, Bar Ḥiyya provides fewer details than al-Farghānī since in most cases he neglects to record the minutes of the northern boundaries of the climes, giving them only for the first and third climes (at 16˚30´ and 30˚30´ respectively).

To aggravate the confusion further, if we compare Bar Ḥiyya's scheme at the beginning of his *ẒA* with what he says in the ninth chapter of the same treatise, a number of discrepancies appear between the two accounts with respect to the boundaries of the sixth and seventh climes.[40] Honigmann supposed that the figures given at the beginning of the *ẒA* for the fifth and sixth climes (40˚ and 48˚ respectively) are corrupt and that they should be amended to 41˚ and 45˚.[41] Abraham bar Ḥiyya's scheme as recorded in the ninth chapter strongly resembles that of al-Khwārizmī, which, in turn, seems to follow the tables given in Ptolemy's *Almagest* II.8, although in al-Khwārizmī's scheme the southern boundary has been moved further down.[42]

In view of these inconsistencies and ambiguities, and given that Bar Ḥiyya was obviously familiar with the writings of several astronomers, it appears that the identification of the sources underlying his scheme of the seven climes is a hazardous enterprise. In his astronomical tables he seems to follow chiefly al-Battānī, who, in turn, was heavily indebted to Ptolemy.[43] His work thus displays the combined influences of Ptolemy and Islamic astronomers. Moreover, it should be noted that a work entitled *(Kitāb fī) ṣūrat al-arḍ* – of which the name of Abraham

[39] Millás Vallicrosa, *La obra forma*, pp. 13-15 and 45, n. 25.

[40] In the first chapter, the seventh clime, for instance, is said to stretch from 48 to 66˚ north, whereas according to the later chapter (*ẒA,* 39r) it comprises only three degrees and thirty minutes (that is to say, from 45˚ to 48˚30´). Millás Vallicrosa, *La obra forma*, p. 47, n. 41.

[41] Honigmann, *Sieben Klimata,* pp. 184-5.

[42] Honigmann, *Sieben Klimata*, pp. 154-5 and p. 161; al-Khwārizmī, *Kitāb ṣūrat al-arḍ,* ed. H. von Mzik (Leipzig, 1926), intr. p. xii.

[43] Harley and Woodward, *Cartography*, II, 97-8.

bar Ḥiyya's book is a literal translation – or *Ṣūrat ma'mūr al-arḍ* with an accompanying map is ascribed to Ptolemy by several authors, for example al-Bīrūnī and al-Mas'ūdī,[44] a work that is no longer extant but which may have served Bar Ḥiyya as a source. It remains unclear whether these authors refer to an original work by Ptolemy, or to an adaptation of his *Geography* in Greek, Syriac or Arabic.[45] Furthermore, as we have seen, a fair amount of confusion pervades the views of the classical and Muslim authors who dealt with the question of the inhabited world, since several schemes co-existed. Finally, it is not certain whether the figures as given in the texts we have at our disposal are correct, as, needless to say, figures are likely to be corrupted in the course of transmission. Bar Ḥiyya himself clearly made no effort to harmonize his two accounts. It must thus be concluded that the question of Bar Ḥiyya's sources regarding the *oikoumene* cannot yet be solved. In fact, it is doubtful whether it can be solved at all, but it seems reasonable to suppose that a renewed and detailed investigation into his astronomical sources – an investigation which presupposes the availability of critical editions of his astronomical writings – may shed further light on the question.[46]

IV. SAMUEL IBN TIBBON

With the next author to be discussed here, Samuel ibn Tibbon, an Aristotelian context looms. This celebrated translator treats the issue under consideration in his *Otot ha-Shamayim* (The

[44] Honigmann, *Sieben Klimata*, pp. 114-5, 125, 135, cf. al-Mas'ūdī, *Kitāb al-Tanbīh*, p. 25.

[45] Ptolemy's *Geography* is reported to have been translated several times into Arabic during the Abassid period, but none of these translations is extant, cf. M. Steinschneider, *Die arabischen Übersetzungen aus dem Griechischen* (Graz, 1960; repr. of *Beiheft V zum Zentralblatt für Bibliothekwesen*, 1889), § 119, and see Harley and Woodward, *Cartography*, II, 10 (Appendix 1) and 98-99. On the term *ṣūrat al-arḍ*, cf. the literature quoted by Honigmann, *Sieben Klimata*, p. 114ff. and p. 184, n. 2 and *Encyclopaedia of Islam*, 2nd. ed., II, 575 s.v. 'Djughrāfiyā' (C. Pellat). Several geographical works that incorporated Ptolemaic material had this title, which translates the Greek word for 'geography', cf. *Encyclopedia of Islam*, 2nd. ed., III, 1076 s.v. 'iḳlīm' (A. Miquel).

[46] In another section of his *ZA* (ed. Basel, 1546, pp. 85-6) the author rejects the theory according to which the climes do not always have the same boundaries, but change their location dependent on the sun's movement. Bar Ḥiyya states that the Greek, Persian, Latin and Muslim sages do not pay attention to this 'error', but believe that animals can change their habitat at each moment depending on God's will. I owe this reference to the reviewer of *Arabic Sciences and Philosophy*.

Signs of Heaven, completed in 1210), which is the Hebrew version of the Arabic adaptation of Aristotle's *Meteorology* by Yaḥyā ibn al-Biṭrīq. As Ibn Tibbon repeatedly underlined, this Arabic version was very defective, which is why he sought to improve upon his model by incorporating material from the commentaries by Alexander of Aphrodisias and Ibn Rushd on Aristotle's *Meteorology*. In general, it can be said that thanks to this procedure Ibn Tibbon succeeded in providing a text that is closer to the Aristotelian original than that of his Arabic model. This is not to say, however, that Ibn Tibbon's editorial zeal resulted in the removal of all of the ambiguities that plagued the Arabic version. As we shall see, neither the Arabic nor the Hebrew version faithfully reproduces Aristotle's position with respect to the *oikoumene*.

The question of the inhabitability of the earth is found in Book Two of Ibn Tibbon's translation, where it forms part of the discussion of winds, or, more precisely, of the question from which directions the winds originate. In the Arabic text of Ibn al-Biṭriq only one paragraph is devoted to our issue, the contents of which boil down to this: the earth consists of an inhabited and an uninhabited part. The uninhabited part, in turn, can be divided into two parts, one that is uninhabitable because of extreme heat (the south) and another that is uninhabitable because of extreme cold (the north). The Arabic translation then goes on to explain that there are twelve different winds and describes their positions in relation to each other.

Although it may be assumed that the Arabic translation intended to reproduce Aristotle's account of the habitability of the earth, as the linking of this issue with that of the origin of winds indicates, it should be noted that the theory it presents bears little if any resemblance to Aristotle's exposition in the *Meteorology*. To begin with, the paragraphs about the inhabited and uninhabited parts of the world as well as the paragraph on the twelve winds are extremely short in comparison with the quite extensive discussion of these topics in Aristotle. What is more important, however, is that a crucial point of Aristotle's theory is missing in the Arabic translation, namely that there is a habitable region in the southern hemisphere that corresponds to the one found in our part of the world. It is precisely this idea that helps Aristotle explain the correspondence of winds in the two zones.[47]

[47] *Meteor*. 362a3-363a19.

For reasons that are not further specified, Ibn Tibbon deemed it necessary to expand upon the material he found in his model. After having translated the relevant passage as he found it in the Arabic, the Hebrew translator interrupts himself by stating that he had found an addition to it in 'the book that I used for the correction of the copy from which I am translating',[48] whereupon he goes on to translate the contents of this supplement.

The first part of the addition reiterates that a part of the earth is inhabited, whereas another part is not. It says that in the region beyond the latitude of 16° south until the south pole no habitation is possible on account of the scorching heat in that region. No ploughing or sowing is possible there, because the air and the earth are burnt. This is even visible in the waters of the Nile that springs in that region, for it contains water that is black as a result of the burnt earth in it. In the north, however, there can be no sowing or harvesting and thus no habitation on account of the severe cold and the ice in that area.[49] What this account has in common with that of Bar Ḥiyya is the idea that the inhabited world lies between two zones, whose temperatures are too extreme for habitation. However, Ibn Tibbon makes no mention whatsoever of the seven climes, nor do the details he furnishes and his terminology reveal any acquaintance with any of Bar Ḥiyya's works.

In most of the manuscripts of the *Otot ha-Shamayim* the text is accompanied by a diagram of the inhabited and uninhabited regions (see Fig. 2, below). This diagram, is, in fact, a combination of two originally distinct diagrams, one representing the position of the twelve winds and the other the *oikoumene*. It consists of a circle, which represents the earth with the names of the winds written around it and of three horizontal lines, the equator (*AB*), the northern limit of the *oikoumene* (*EZ*) and the southern one (*HT*). The north pole is indicated by point *C* and the south pole by *D*.

Ibn Tibbon's explanation of this illustration constitutes the second part of his addition to the Arabic version. Pointing out that the northern hemisphere is formed by the part *ABC*, he

[48] See my edition of this text, *Otot ha-Shamayim. Samuel Ibn Tibbon's Hebrew Version of Aristotle's Meteorology*. A critical edition with introduction, translation, & index (Leiden, 1995), Book II, lines 356-357.

[49] *Ibid.*, lines 359-372.

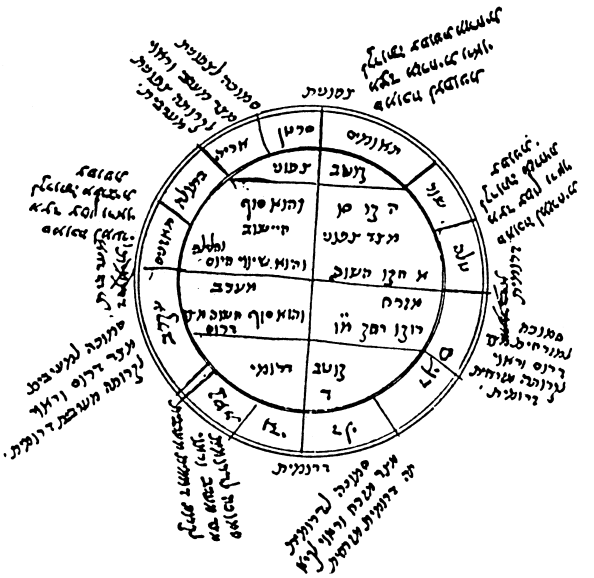

Fig. 2
The zones of habitation, according to Samuel ibn Tibbon, *Otot ha-Shamayim*, MS Paris héb. 189/2, fol. 131[r]. (By permission of the Bibliothèque Nationale de France)

states that the line *EZ*, which is parallel to the equator and which is to be situated at a latitude of 66° north, marks the end of the habitable world: beyond this latitude habitation is impossible. Habitation in the northern hemisphere is thus limited to the section *ABEZ*. Correspondingly, the southern hemisphere consists of an inhabited and an uninhabited part. Habitation is impossible in the area *HTD*, *D* being the south pole and the line *HT* running parallel to *EZ*, or, as Ibn Tibbon puts it, being 'like *EZ*'.[50]

However, the interpretation of Ibn Tibbon's explanation of the diagram presents a problem in that, according to some manuscripts, the line *HT* on the southern hemisphere is to be situated at a latitude of 16° south, whereas other manuscripts situate it at 66° south. It is not easy to determine which reading is the original one.[51] On the one hand it can be argued that the figure of 66° is a corruption of 16°, given that figures are liable

[50] *Ibid.*, Book II, lines 373-381.

[51] In most of the manuscripts the illustration is incomplete as to the figures, points and lines mentioned in Ibn Tibbon's description.

to distortion and that a southern limit of 16° would be in line with the first part of the account. On the other, the reading 66°, which is the reading of the majority of the mss., is consonant with Ibn Tibbon's statement that the line *HT* 'is like' the line *EZ*, at least if this is taken to mean that it is to be situated at the same latitude as its counterpart on the northern hemisphere. Following this interpretation, it may be dangerous to reject the variant reading 66° as a mere corruption. It can be assumed instead that this reading reflects a knowledge of the Aristotelian theory according to which two matching zones of habitation are assumed to exist, a notion, which, as we have seen, was not preserved in the Arabic translation. Since, according to this theory, the *oikoumene* on the southern hemisphere was symmetrical to that of the northern, a limit to the habitable world at 66° on the southern hemisphere would only be logical. As we will shortly see, later authors indeed adopted this figure. The reading may have originated with Ibn Tibbon, in which case it is due to his editorial efforts, or with a learned scribe who was somehow familiar with Aristotle's view on the *oikoumene*. Unfortunately, Ibn Tibbon does not specify from which source his information derives, limiting himself to saying that "apparently it (the addition) was an explanatory addition in the margin (of the copy he used for correction), which the scribe inserted into the text."[52] It should be conceded, however, that if it is indeed Aristotelian influence that underlies the variant reading, Aristotle's view is presented in a mutilated or simplified form; for Aristotle distinguished five zones with regard to the question of habitability, whereas in Ibn Tibbon's addition four zones are discernible, the equatorial zone not being treated as a separate zone.

V. IBN RUSHD

As was stated above, the thirteenth-century Hebrew encyclopedists drew heavily on Ibn Rushd in their survey of the sciences. Ibn Rushd's views on the *oikoumene* can be found in the two commentaries he wrote on Aristotle's *Meteorology*, the Epitome[53]

[52] *Otot ha-Shamayim*, Book II, lines 357-358.

[53] For the Epitome I refer to the edition given in *Rasā'il Ibn Rushd. Jawāmi' al-Āthār al-'ulwiyya*, ed. Dā'irat al-ma'ārif al-'uthmāniyya (Hyderabad, 1947).

and the Middle Commentary.[54] I will limit myself to highlighting those aspects of Ibn Rushd's treatment that are relevant for the discussion of his Jewish followers.

As was his procedure in his other Epitomes on Aristotle's natural philosophy, Ibn Rushd does not offer a precise rendering of Aristotle's *Meteorology* in his Epitome to this text, rearranging and paraphrasing, instead, its contents. In contrast, the Middle Commentary follows the Aristotelian text closely. It would seem that the text underlying both commentaries is the same corrupt version that was Samuel ibn Tibbon's model, the Arabic paraphrase by Yaḥyā ibn al-Biṭrīq. In both commentaries Ibn Rushd refers to this text as 'the version which has come down to us'. In all probability, Ibn Rushd had no other translation of the *Meteorology* at his disposal.[55] To arrive at a better understanding of the Aristotelian text, he consulted Alexander of Aphrodisias' commentary on Aristotle's treatise.

It should be noted that there are several differences in the treatment of the *oikoumene* between the two commentaries. For example, in the Epitome Ibn Rushd states that the *oikoumene* comprises about 1/6 -1/7 of the earth and that, on the basis of sense-perception, it is to be situated between approximately 13° south to 60° north.[56] No such figures are given in the Middle Commentary. A more important difference, however, is that in the Epitome Ibn Rushd presents the theory that there are two habitable zones between the tropics and three uninhabitable zones towards the poles and around the equator as the opinion of 'Aristotle and the Peripatetics in general'. In contrast, the Middle Commentary, ascribes to Aristotle the theory that divides the earth into two parts: one habitable and the other one uninhabitable, the latter divided into a region that is uninhabitable because of extreme cold and a region that is uninhabitable because of extreme heat.[57] Since it appears from the context that this is a description of the northern hemisphere,

[54] For the Middle Commentary I refer to the edition by Jamal Eddine Alaoui, *Talkhīṣ al-Āthār al-'ulwiyya* (Beyrouth, 1994). The Hebrew translation of this commentary (made by Kalonymus ben Kalonymus) was edited as a Ph.D thesis by I.M. Levey, *The Middle Commentary of Averroes on Aristotle's Meteorologica* (Harvard, 1947). This translation will be referred to as Kal.

[55] Cf. G. Endress in his review of C. Petraitis, *The Arabic Version of Aristotle's Meteorology* (Beyrouth, 1967), *Oriens,* 23-24 (1974): 497-509, p. 503 and *Otot ha-Shamayim*, introd., pp. lxix-lxxi.

[56] *Jawāmi'*, p. 44.

[57] *Talkhīṣ*, p. 111.1-7 = Kal., p. 88.6-13.

this account cannot be considered to be a precise description of the five-zones theory. Instead, it corresponds exactly to what Ibn al-Biṭrīq said in the Arabic translation of Aristotle's *Meteorology*, and consequently, to Ibn Tibbon's translation of this section. While observing that this is Aristotle's view 'according to the version that has come down to us',[58] Ibn Rushd contrasts this view with the theory held by 'the commentators who claim that the earth can be divided into five parts, two of which are habitable (…) whereas three are not'.[59]

It will thus come as no surprise that the two commentaries also offer divergent views on the habitability of the moderate zone in the southern hemisphere. The Epitome states that Aristotle taught that the two temperate zones were inhabited,[60] whereas in the Middle Commentary Ibn Rushd sets out to investigate 'why Aristotle has not divided the southern hemisphere into an habitable and an uninhabitable part as he did with the northern hemisphere'. In this regard he even alludes to 'Aristotle's silence with respect to the habitability of the southern hemisphere'.[61] As a possible explanation for Aristotle's reluctance to divide the southern hemisphere into a habitable and an uninhabitable part, Ibn Rushd adduces the argument that water prevails over earth and that the place occupied by water is larger than that occupied by land much as air, in turn, is larger than water. This consideration, Ibn Rushd suggests, may have prevented Aristotle from adopting the existence of inhabited areas in the southern hemisphere.[62]

As for the question of whether the conditions in the equatorial zone allow for life, what both commentaries have in common is that Ibn Rushd reiterates Aristotle's position that this is impossible. However, while observing in his Middle Commentary that 'many people' do not adopt Aristotle's view that the torrid zone is uninhabited[63] and that the theory according to which the region near the equator is 'equal' is unintelligible (*ghayr*

[58] *Ibid.*, p. 111.8-9 = Kal., p. 88.13.
[59] *Ibid.*, p. 111.11-17 = Kal., pp. 88.15-89.3 and cf. also p. 112.3-4 = Kal., p. 89.9-10.
[60] *Jawāmi'*, p. 45.
[61] *Talkhīṣ*, p. 111.18 = Kal., p. 89.4.
[62] *Ibid.*, p. 111.18-112.4 = Kal., p. 89.4-10. The same argument appears in the Epitome, where Ibn Rushd raises the difficulty of how the assumption of the existence of land masses in the north is to be reconciled with the preponderance of water over land on the global surface after having rejected Aristotle's position that there is a corresponding moderate zone in the southern hemisphere (*Jawāmi'*, pp. 50-1).
[63] *Talkhīṣ*, p. 112.7-9 = Kal., p. 89.12-13.

ma'qūl),[64] he refrains from attributing this theory to Ibn Sīnā, although it was widely known that this scholar had upheld the theory that the equatorial zone could support life.[65] In contrast, in the Epitome Ibn Rushd unambiguously ascribes the theory of the habitability of the torrid zone to Ibn Sīnā, explaining that Ibn Sīnā followed Ptolemy in this on the grounds that the view of the Peripatetics contradicted perception and reason.[66]

In support of his thesis Ibn Sīnā put forth the arguments used by Posidonius, namely that the sun passes quickly over the equator whereby this region enjoys a more moderate climate than do the tropics where the sun lingers for a long time, and the equal length of day and night at the equator. Arguing that the area around the equator was the middle between two extremes (that is, the tropics) Ibn Sīnā held it to be neither too hot nor too cold.[67] In his view, it was always spring in that region.[68]

Ibn Rushd went to great lengths to defend Aristotle's position against Ibn Sīnā. While admitting in the Epitome that there is life in the torrid zone, he claimed that this way of life was generally not natural.[69] The extreme heat in this region is caused not only by the agent (*fā'il*), the sun, which is directly overhead, the infalling sunrays making right angles with the earth, but also by the 'receiver' (*qābil*), that is the air which is not in a position to cool as the sun is never away for more than three months. In other words, this region is not suitable for plants and animals given that these living beings require the seasons to grow and thrive.[70] Moreover, Ibn Rushd employed the

[64] *Ibid.*, p. 114.1 = Kal. p. 91.7.

[65] Latin authors, too, quoted Ibn Sīnā as having upheld the habitability of the equatorial zone, cf. Lynn Thorndike (ed.), *The Sphere of Sacrobosco and its Commentators* (Chicago, 1949), pp. 188-90 (Latin text; Engl. trans. pp. 237-9). Michael Scotus rejected his view, whereas Albertus Magnus and Roger Bacon belonged to the adherents of the habitability of this zone, cf. W.G.L. Randles, *De la terre plate au globe terrestre. Une mutation épistémologique rapide 1480-1520* (Paris, 1980) p. 14, n. 18.

[66] *Jawāmi'*, p. 45.8-13, cf. Ibn Sīnā, *al-Shifā', al-Ṭabī'iyyāt*, vol. II, pt. 5 *Al-Ma'ādin wa al-Āthār al-'ulwiyya*, ed. A. Muntaṣir a.o. (Cairo 1965), I, 6, p. 27.2-3.

[67] *Al-Shifā', al-Ṭabī'iyyāt,* pp. 29-30.

[68] *Ibid.,* p. 30.13-14. As is well known, in his *Ḥayy ibn Yaqẓān* Ibn Ṭufayl defended the view that the moderateness of the equatorial climate can give rise to the spontaneous generation of human beings, although he admits that this only seldom occurs, cf. L. Gauthier, *Hayy ben Yaqdhan. Roman philosophique d'Ibn Thofail*. Texte arabe et trad. (Alger, 1900), pp. 17-19.

[69] *Jawāmi'*, p. 46.18.

[70] *Ibid.*, pp. 46-8.

'argument from symmetry' which, he believed, was implicit in Aristotle's account. This argument implies that there must be a region that is uninhabitable due to heat since there is a region that is uninhabitable due to cold. Arguing that we find one of the extremes (an uninhabitable cold region in the north) and a middle (the temperate zone), he concluded that the other extreme (an uninhabitable hot region in the south) must also exist.[71]

In his Middle Commentary Ibn Rushd elaborated on these arguments, taking as his starting-point the thesis that the uninhabitability of the equatorial zone can be proven by perception and reason together and by reason alone. The proof based on perception and reason says that the way of life of the Kushites who live near the Summer tropic is not natural. Their temperament deviates from that of human beings and, in fact, represents the extreme of the spectre of the human temperaments. They can only live in that region because there are caves, which they use as their dwelling-places, much as animals seek shelter near stones and water.[72] Their way of life therefore resembles that of those who live towards the end of the northern *oikoumene*. From this it follows logically, Ibn Rushd continues, that in regions where it is even hotter (i.e., at the equator), habitation is totally impossible. For this region is necessarily hotter, since it has the sun directly overhead twice a year, whereas the sun passes over the tropics only once a year.[73]

As for the proof yielded by reason, this is constituted by the aforementioned argument that there must be a zone of extreme heat in the south that corresponds to one of extreme cold in the north since logic requires that for every extreme there is a counterpart.[74] In support of this proof, Ibn Rushd drew an analogy with Aristotle's line of reasoning in the *De Caelo* where the philosopher points out that much as there is a body of extreme

[71] *Ibid.*, pp. 48-9.

[72] *Talkhīṣ*, p. 113.2-9 = Kal. p. 90.7-12. For the notion that people living at the extremities of the civilized world constituted a lower class of human beings see S. Harvey, 'A new Islamic source of the *Guide of the Perplexed*', in *Maimonidean Studies*, 2 (1991): 31-59, pp. 36-41 and especially p. 40, n. 27 for the literature quoted there. Cf. also A. Melamed, 'Erez Yisra'el we-ha-te'oriyah ha-aqlimit ba-mahshavah ha-yehudit', in M. Hallamish and A. Ravitzky (eds.), *The Land of Israel in Medieval Jewish Thought* (Hebr.) (Jerusalem, 1991), pp. 52-78, p. 59 ff.

[73] *Talkhīṣ*, pp. 113.10-114.2 = Kal. p. 90.12-91.7.

[74] *Ibid.*, p. 114.10 ff = Kal. 91.16 ff.

weight, there should also be a body of extreme lightness.[75] To this Ibn Rushd added another proof that argues, along similar lines, that the existence of extreme cold, which is brought about by extreme distance from the sun and extreme slowness of motion of parts of the sphere, implies the existence of extreme heat which is effected by extreme nearness to the sun and extreme rapidity of motion of the parts of the sphere.[76] According to Ibn Rushd, these are the two 'natural and correct demonstrations' Aristotle provided in support of the uninhabitability of the torrid zone. He also observes that neither Alexander nor other commentators pointed out that these proofs were implicit in Aristotle's account.[77]

Finally, it should be noted that in both commentaries Ibn Rushd singles out his native soil, al-Andalus, as enjoying a priviliged position since it is lies in the most moderate climate. However, whereas in the Epitome Ibn Rushd says that the fourth and the fifth clime are the most moderate (and therefore the best) climes,[78] in the Middle Commentary he claims that contrary to what most people think the fifth clime (in which al-Andalus is situated) is the most temperate clime, following Galen in this respect.[79] According to Ibn Rushd, this priviliged position explains why al-Andalus has produced such excellent scientists.[80] Incidentally, it is worth noting that in the Epitome Ibn Rushd does not make a sharp distinction between the five-zones theory and the seven-climes theory, for his statement that he will investigate the question of the most temperate clime (*a'dal al-aqālīm*)[81] is found within his discussion of the five-zones theory which, as we have seen, he attributes to Aristotle.

[75] *Ibid*., p. 115.3-5.
[76] *Ibid*., p. 115.7ff.
[77] *Ibid*., p. 116.5 ff.
[78] *Jawāmi'*, p. 46.9-10. In this commentary Ibn Rushd puts forth the position of al-Andalus as the most temperate clime in connection with his refutation of Ibn Sīnā's thesis that the equatorial zone is the most temperate region.
[79] *Talkhīṣ*, pp. 103-4 and *Kitāb al-Kulliyāt fī al-ṭibb*, ed. J.M. Fórneas Besteiro-C. Alvarez de Morales (Madrid, 1987), vol. I, p. 103.
[80] For this notion, cf. A.I. Sabra, 'The Andalusian revolt against Ptolemaic astronomy. Averroes and al-Biṭrūdjī', in E. Mendelsohn (ed.), *Transformation and Tradition in the Sciences. Essays in honor of I. Bernard Cohen* (Cambridge etc., 1984), pp. 133-53, pp. 143-4.
[81] *Jawāmi'*, p. 45.11. Cf. Honigmann, *Sieben Klimata*, pp. 19 and 26.

VI. JUDAH BEN SOLOMON HA-COHEN

6.1. *Aristotle's* Meteorology *in the* Midrash ha-Ḥokhmah

The first of the Hebrew authors to make a large-scale use of Ibn Rushd's commentaries was Judah ben Solomon ha-Cohen, who, in his *Midrash ha-Ḥokhmah* (hereafter abbreviated as *MḤ*) attempted to provide a survey of contemporary science and philosophy. Originally written in Arabic, presumably in the thirties of the thirteenth century, the Hebrew translation made by the author himself dates from ca. 1247.[82] Only 35 years had elapsed between the time of the composition of the Hebrew version and that of Ibn Tibbon's translation of Aristotle's *Meteorology*, but the two authors differ significantly in their presentation. In contradistinction to Samuel ibn Tibbon, Judah also provided information as to the extent to which the Aristotelian view had found acceptance by indicating where doubts had been raised by later authors. In other words, he recorded not so much the Aristotelian theory as the contemporary discussion ensuing from this theory. In other sections devoted to natural philosophy he adopted the same procedure, noting opinions that were put forward by later authorities or criticizing Aristotelian views. Another difference with Ibn Tibbon's work lies in the fact that in the *MḤ* the question of the earth's habitability features as a separate issue, its connection with the position and origin of winds no longer being discernible, although it does appear in his survey of Book Two of Aristotle's *Meteorology*. There are no indications that Judah used Ibn Tibbon's translation of this text, or the Arabic version. His terminology and the order of presentation clearly show that he drew instead on Ibn Rushd's two aforementioned commentaries on the Arabic version of the *Meteorology*, as well as on Ptolemy's writings, and occasionally on Ibn Sīnā's *Shifā'*.

Judah begins by observing that everyone agrees that there is habitation in one of the quarters of the northern hemisphere,

[82] The section to be discussed here is found in MS Oxford Poc. 343, fols. 43^{v}-44^{r}. For the author and his work, cf. C. Sirat, 'Judah b. Salomon ha-Cohen. Philosophe, astronome et peut-être kabbaliste de la première moitié du XIII^{e} siècle', *Italia*, 2 (1977): 39-61 and most recently, M. Zonta, *La filosofia antica nel Medioevo ebraico* (Brescia, 1996), pp. 200-4.

since this is proven by reason and by experience, a formula that is reminiscent of both of Ibn Rushd's commentaries.[83] However, he continues, habitation in the northern hemisphere is confined to an area of 42°. This inhabited region is situated between the latitude of 24° (the tropic) and 66°, the outermost border of the inhabited world where the longest day in summer and the longest night in winter last 24 hours. Beyond this latitude, habitation is impossible because of the cold. Judah thus provided different figures from Ibn Rushd; apparently seeking to offer a more precise delineation of the inhabited portion of the earth.

Judah then goes on to advance, with some hesitation, the theory that a corresponding habitable zone exists in the southern hemisphere. To explain this, he points out that there are three zones that are uninhabited owing to extreme climatological conditions, namely the two polar zones, where it is too cold, and the torrid or equatorial zone, where it is too hot. The two zones that lie in between – the regions between the tropics and the arctic circles – are temperate and therefore habitable. Judah does not say explicitly that the southern temperate region is habitable or inhabited; he merely says that habitation there is 'not impossible'. Taking into consideration that in his day the question of how far habitation to the south was possible was still a matter of scholarly debate, his hesitation is not surprising. Moreover, as we have seen, his major sources, the two commentaries by Ibn Rushd, give divergent and even conflicting descriptions of Aristotle's view, and this may also account for Judah's reservation.

It is difficult to infer from his words what his own opinion on the matter was. At the end of his discussion Judah reproduces the argument that Ibn Rushd advanced in explanation of Aristotle's alleged 'silence with respect to the southern hemisphere', namely that 'the place of water ought to be larger than the place of earth'. Judah presents it as 'another cause for the impossibility of the whole of these two regions to be inhabited'. In other words, he seems to admit that at least parts of these regions were habitable, although he concludes his survey of this section of the *Meteorology* by stating that only the habitation of the northern hemisphere has been proved. Therefore, even

[83] *Talkhīṣ,* p. 112.6 = Kal. p. 89.12 ff. Cf. also *Jawāmi'*, p. 44.10. We find a similar phrasing in Strabo: Strabo, *Geogr*. 2.5.5: 'the evidence of our senses and of reason prove this', trans. H.L. Jones, I, 433.

though he goes on record as accepting as true only that which has been undubitably proved, one gains the impression that he felt attracted to the theory that the southern region was habitable. Another indication of this is the fact that he pays considerable attention to the theory of the five zones and illustrates it with a diagram (see Fig. 3 below), so as to grant it greater authority or at least credibility. More important, however, is another statement a bit later on to the effect that it is 'not impossible' that the *oikoumene* in the southern hemisphere forms a continuous belt, for these words suggest that he assumed this region to be not only habitable but, in fact, inhabited.

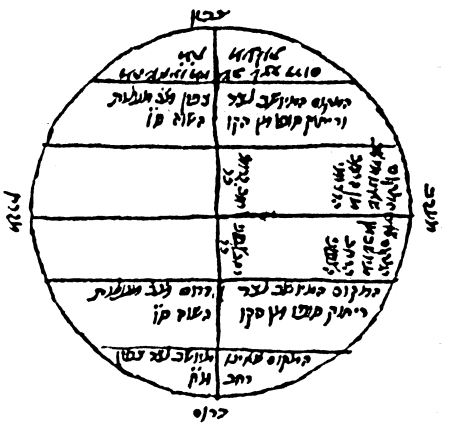

Fig. 3
The five zones, according to Judah ben Solomon ha-Cohen, *Midrash ha-Ḥokhmah*, MS Leiden, Or. 4758, fol. 38^{v}.
(By permission of the Rijksuniversiteit Leiden)

As for the three uninhabitable regions, Judah ha-Cohen accounts for the uninhabitability of the polar zones by employing the same arguments Ibn Rushd put forward in the Middle Commentary, namely the extreme cold that reigns there and the slow motion of the sphere.[84] His observation that, at the north pole, a day lasts half a year also follows Ibn Rushd who explained in this context that the ratio between day and night in the polar regions make this area unfit for human settlement.[85]

The so-called torrid zone is declared uninhabitable by Judah ha-Cohen, but he nevertheless feels called upon to inform the

[84] *Talkhīṣ*, p. 112.16-17 = Kal., p. 90.4.
[85] *Ibid.*, p. 112.9-16 = Kal., pp. 89.15-90.3.

reader that opinions differ with regard to this hotly debated question by noting that, according to Ibn Sīnā, habitation is possible in the equatorial zone and that Ibn Rushd had opposed this view. However, the Hebrew author refrains from presenting any of Ibn Rushd's arguments against Ibn Sīnā's theory. It may be justifiably asked whether this omission in combination with Judah ha-Cohen's recording of Ibn Sīnā's deviating opinion implies that he tacitly subscribed to this view. In my opinion, however, the answer must be in the negative. That Judah does not go into detail does not furnish any proof, brevity being one of the salient characteristics of the *MḤ*. Furthermore, not only did the encyclopedist explicitly include the torrid zone in the three uninhabitable regions, he also refrained from using the words 'this is not impossible' with respect to this theory, the very words he did use when mentioning the theory that the southern temperate region was habitable. The absence of these words may be taken to imply that he did not accept Ibn Sīnā's theory.

In contrast, Judah ha-Cohen does use words of similar import ('nothing prevents us from assuming') in connection with another issue of the discussion of the *oikoumene*, namely the question of whether the western quarter at the other side of the ocean was habitable. One looks in vain for this theory in the Middle Commentary, whereas in the Epitome Ibn Rushd rejected this assumption.[86] Apparently pursuing this line of thought, Judah also states that it is 'not impossible' for some oceanic islands to be inhabited provided they are situated in one of the two moderate zones, a notion that perhaps goes back to Eratosthenes who also defended the existence of inhabited islands in the ocean. In neither of his commentaries on the *Meteorology* does Ibn Rushd refer to inhabited isles.

It is noteworthy that, compared to other issues dealt with in his survey of the *Meteorology*, Judah devotes much attention to the question of the *oikoumene*. One gains the impression that Judah found the idea of a *terra incognita* beyond the conventionally recognized boundaries highly attractive. At the same time, it is clear, however, that he hesitated to wholeheartedly subscribe to unproved views. As for the term 'one of the quarters of the northern hemisphere', which we encounter here as well as in Judah's sources, it would seem that this term goes

[86] *Jawāmi'*, p. 51.6.

back to the ancient view according to which the inhabited world consists of four quarters or islands diametrically opposed to each other and separated by oceans, a theory which is generally ascribed to Crates of Mallos (fl. 150 b.c.e).[87] However, given that neither Ibn Rushd nor Judah ha-Cohen believed that the equatorial zone is covered by an unsurpassable ocean (as some contemporary Christian authors held), the use of this term by authors does not reflect the acceptance of the idea itself.[88]

6.2 *Ptolemy's* Tetrabiblos *in the* MḤ

Thus far we have seen that the *MḤ* addresses more questions pertaining to the distribution of the populated areas of the earth than did the earlier Hebrew writings discussed here, namely Abraham bar Ḥiyya's two treatises and the *Otot ha-Shamayim*. Moreover, references to the seven-climes theory are found in the astronomical section of his work that summarizes Ptolemy's *Almagest*.[89]

In the astrological section of the *MḤ*, yet another aspect of the question of the *oikoumene* comes to the fore. This section, which belongs to the astronomical part of the *MḤ*, is, in fact, a resumé of Ptolemy's *Tetrabiblos*.[90] In his *Tetrabiblos* Ptolemy dealt with the way in which the stellar constellation that reigns over a given region influences the mental constitution of its inhabitants. In his survey, Judah ha-Cohen follows his source closely, pausing, however, at certain intervals, when he deemed it necessary to comment on some statement by Ptolemy.[91] Judah begins by outlining the contents of *Tetrabiblos* I, describing how the

[87] Cf. Romm, *Edges of the Earth*, p. 130 and Harley and Woodward, *Cartography,* I, 163.

[88] According to Randles, *De la terre plate,* pp. 12-14, Crates' terminology also remained in use when in the course of time under the influence of the five-zones theory these four islands 'merged' into two moderate zones.

[89] For example MS Oxford, Mich. 551, fol. 158^{v}.

[90] This part of the *MḤ* was edited under the title *Otot ha-Shamayim, Hu Sefer Mishpete ha-Kokhavim* by J. Spiro (Warsaw, 1886). I wish to thank Dr Adri K. Offenberg and Dr Annelies Kuyt for providing me with copies of this edition. For the passages to be discussed here, cf. pp. 4^{r}-5^{r}.

[91] The author introduces his section on astrology with a kind of apology, in which he attempts to justify the use of astrology and discusses some Rabbinic utterances regarding the influence of the stars. Nonetheless, it is clear from other sections of his encyclopedia, that he was much given to astrology.

stars and planets influence the lower bodies and presenting Ptolemy's views on masculine and feminine planets, nocturnal and diurnal ones. He also provides a brief description of the power of the fixed stars, i.e., the twelve signs of the zodiac, in relation to that of the planets. He then goes on to present Ptolemy's theory according to which the collective character of the inhabitants of a given region is influenced by the heavenly bodies, in particular the sun. Ptolemy dealt with this theory at great length in Book II. Following his source, Judah first describes the general characteristics of the peoples dwelling in the hot, cold and temperate zones as conditioned by the sun and then moves on to a more detailed investigation of the mental constitution of the four quarters of our inhabited world.[92]

According to his description, the people who live close to the summer tropic, that is the black-skinned Ethiopians who have the sun directly overhead, are like wild beasts of the desert in their habits, owing to their constant exposure to the sun's heat. In contrast, the inhabitants of more northern regions, especially those who live under the Small Bear, are cold and moist [in constitution] because they are far removed from the zodiac and the heat of the sun. These people are of white skin, their hair is fine and their bodies are well-nourished and vigorous. Like their southern counterparts, they are also comparable to wild beasts in their habits. By contrast, the people who live in the moderate zone, that is between the summer tropic and the Bears, do not have the sun above them and are characterized by moderation as regards their physique, while their nature is good and their 'disposition pleasant to people', as Judah puts it borrowing a Talmudic expression.[93] To this he adds that of the people of the intermediate regions it can be said in general that those living to the south are more intelligent, of sharper wit and given to astronomy.

In this passage we thus come across the same theory we found in Ibn Rushd's Middle Commentary (cf. above section V), namely that civilization was far less developed at the extreme ends of the *oikoumene* than it was in the middle and that

[92] It should be noted that these quarters are not those referred to earlier in connection with Crates' division (cf. above, end of section 6.1). What Ptolemy refers to are the four quarters of the known world in the northern hemisphere, which together comprised the known portions of Europe, Asia and Africa.

[93] Cf. Talmud Bavli, Ketubbot, 17a.

human beings at the periphery of the inhabited world resembled animals. Given the context, however, it may be assumed that Judah's rendering of this wide-spread notion here is taken from Ptolemy's *Tetrabiblos* rather than from Ibn Rushd's commentary.[94]

Equally widespread among Muslim and Jewish authors was the notion underlying this theory, namely that the physical and psychological constitution of the inhabitants of a given region is determined not only by the influence of the heavenly bodies, but also by climatological factors such as heat and cold, a notion that goes back to antiquity. As Altmann stated in his much quoted article on the impact of this theory on Judah Halevi's prophecy, it was Hippocrates who can be rightfully called the 'father of environmental climatology'.[95] Hippocrates was the first to underscore the importance of the climate for vegetation, animal life and on the constitution of human beings. Later Posidonius combined this idea with the division of the earth into three zones of temperature, cold, hot and moderate.[96] Hippocrates also discussed the effect of climatological conditions on human intelligence, describing primarily the differences in physique, shape and character of Europeans and Asians. With later authors, the effect of heat and cold on human intelligence became a popular theme, probably as a result of Aristotle's influence.[97] In any event, many

[94] *Tetrabiblos* II.2 In Judah's Hebrew text 'de'ot' (lit.: opinions) renders the Greek 'ethos' (nature, character, habit). The same theory may have underlied Bar Ḥiyya's statement that the people dwelling in the far south were cursed by God (cf. above, section III).

[95] Altmann, 'The climatological factor', p. 2. Cf. also G. Freudenthal, 'Maimonides' stance on astrology in context: cosmology, physics, medicine and providence', in F. Rosner and S. Kotteck (eds.), *Moses Maimonides. Physician, Scientist, and Philosopher* (Northvale, N.J. and London, 1993), pp. 77-90, pp. 82-3. For the consequences of this theory for human speech and the development of language, cf. I.E. Zwiep, *Mother of Reason and Revelation. A Short History of Medieval Jewish Linguistic Thought* (Amsterdam, 1997), pp. 193-7.

[96] Altmann, 'The climatological factor', p. 4, cf. Kidd, *Posidonius*, II (ii), 745 and II (i), 230-1.

[97] Cf., for example, *Problemata Physica* XIV.15 (= p. 626-642 of L. Filius' forthcoming edition of the Arabic translation of this text. I wish to thank Dr. Filius for providing me with a copy of this passage). According to H. Flashar, *Aristoteles. Werke in deutscher Uebersetzung*. Bd. 19 (Darmstadt, 1962), p. 564, this discussion goes back to *Pol*. 1327b23-29 where Aristotle explained that climatological circumstances determine the differences with regard to intelligence, skill and political organization between Europeans and Asians: the inhabitants of cold climates (that is, Europeans) are full of spirit, but wanting in skill and intelligence, whereas the Asians are intelligent, but wanting in spirit. Plato associated intelligence with a moderate climate in *Timaeus* 24c.

centuries later Ibn al-Ṭayyib (d. 1043) attributed to Aristotle the view that it is better for creative minds to live in warm countries, whereas people who complete and perfect the achievements of original thinkers should rather live in cold countries, since such people must be calm and steady.[98] Judah's statement that in general people living to the south are more intelligent and given to astronomy apparently reflects Ptolemy's conviction that these people are 'better versed in the knowledge of things divine' and better equipped for the pursuit of the mathematical sciences.[99]

Given the general acceptance of these theories, it should come as no surprise that Judah ha-Cohen seems to have no problems with the information provided by his source thus far. The picture changes, however, when it comes to astrologically determining the national character of particular peoples. Following his source, Judah explains that each of the four quarters of our inhabited world is related to three of the signs of the zodiac and that the character traits of the inhabitants of a given quarter are conditioned by the influence of this triangle and the planets that dominate that quarter. In Ptolemy's description, the region in which the Land of Israel is situated lies towards the centre of the south-eastern quarter and this region is associated with the triangle of Aries, Leo and Sagittarius and governed by Jupiter, Mars and Mercury. As a result, the inhabitants of that region are given to trade and treachery. In Syria and the land of Israel, Aries and Mars are particularly influential, entailing that the populace are stupid and lack knowledge of God. In these words Judah renders what Ptolemy wrote in *Tetrabiblos* II.3, namely 'that peoples of these regions are more gifted in trade and exchange' and: 'they are more unscrupulous, despiceable cowards, treacherous, servile and in general fickle.'[100]

Unlike 'Alī ibn Riḍwān who commented on the *Tetrabiblos* without showing any sign of amazement or indignation at Ptolemy's unfavourable description of the national character of the inhabitants of Syria and Palestine,[101] Judah felt called upon

[98] Quoted by Hein, *Definition,* p. 252 and by F. Rosenthal, *The Classical Heritage in Islam* (London, 1975), pp. 70-1.

[99] *Tetrabiblos* II.3, ed. and trans. F.E. Robbins (London and Cambridge, Mass. 1956), p. 125.

[100] Trans. Robbins, p. 143.

[101] Cf. the English translation of this fragment in Rosenthal, *Classical Heritage*, pp. 243-5.

to refute Ptolemy vigorously. While accepting unconditionally the general theory that the mental constitution of a given people is determined by the stars, he set out to challenge Ptolemy's conclusions with regard to the inhabitants of the Land of Israel.[102]

First of all he invokes the argument that this area is situated in the most moderate part of the *oikoumene*. Although he does not further elaborate on this, the implication is clear: as we have seen, it was generally agreed that the inhabitants of the moderate part of the inhabited world excelled those living at the edges of civilization with regard to physical and intellectual properties. In other words, the inhabitants of the Land of Israel, which was usually situated in the fourth clime and hence characterized by moderation, could not possibly possess such excessively mean characteristics. This argument, only briefly hinted at by Judah, reflects the *communis opinio* of medieval Jewish authors with respect to the privileged position of the Land of Israel.[103] By taking this point of view they rejected *ipso facto* the claim often put forward by Muslim authors that either Iraq[104] or Andalusia,[105] each of which was situated in the middle clime, was a superior place to live in.

Furthermore, Judah criticized Ptolemy for having failed to take the powers of the other signs of the zodiac into consideration, which are also influential in determining national characters. Ptolemy, Judah believed, attached far too much importance to the power of the planets, thus, to quote Judah, 'occupying himself with what is secondary while neglecting what is essential, which is why we should not rely on him.'[106] According to Judah, in establishing the mental outlook of a given people, the influence of the totality of the fixed stars should be taken into account, not only that of the three stars that dominate that particular region.[107]

He also invokes a passage from the Talmud, which begins

[102] Sirat briefly dealt with Judah's reply to Ptolemy in her article 'Judah b. Salomon ha-Cohen', p. 47.

[103] For the different views as to whether the land of Israel is unique in this respect, cf. Melamed's article, 'Erez Yisra'el we-ha-te'oriyah ha-'aqlimit'.

[104] As maintained for example by al-Mas'ūdī, cf. *Kitāb al-Tanbīh*, pp. 55 ff. Cf. also *Encyclopedia of Islam*, 2nd ed., III, 1077.

[105] For Ibn Rushd's position, cf. above section V.

[106] Ed. Spiro, 4^{v}.

[107] *Ibid.*, 5^{r}.

'Ten ḳabs of wisdom descended to the world: nine were taken by the land of Israel and one by the rest of the world'. In the same proportion, the author goes on to quote this Talmudical passage, properties such as beauty, wealth, poverty, conceit and witchcraft were distributed to Jerusalem, Rome, Babylon, Elam and Egypt respectively.[108] This passage, Judah believed, proved Ptolemy wrong, for it shows that, contrary to the astronomer's view, wisdom is the quality that has been bestowed most generously upon the land of Israel.

Finally, when describing in accordance with his source the characteristics of the inhabitants of the south-west quarter of the *oikoumene* who are governed by Cancer, Scorpio and Pisces, Judah raises the question why Ptolemy did not assign equal stupidity and lack of knowledge of God to these people, given that Mars strongly dominates Scorpio. That Ptolemy failed to do so he finds the more amazing since Scorpio is a 'false' sign whereas Aries – which is related to the Land of Israel – is a 'true' sign. To this he adds that if the Land of Israel had belonged to the Greeks, Ptolemy would doubtless have praised its qualities. However, while admitting that Ptolemy's account contains many contradictions, Judah is prepared to admit that perhaps it is not Ptolemy who is to be blamed for this incorrect description. He suggests that the challenged passage may be an addition by the Arab translator who wrote it out of his own hate for Israel, since 'all people envy Israel because of its sacred Torah.'[109] Apparently he found it hard to believe that Ptolemy himself can be responsible for such objectionable notions.

It can thus be concluded that Judah ha-Cohen was familiar with several aspects of the question of the earth's habitability. He also refers to the issue under consideration in one of the treatises he appended to his encyclopedia, namely his Explanation of Biblical verses where he informs his readers about the astronomical origin of geographical divisions. In his view Ps. 19:6 'His going forth is from the end of the heaven, and his circuit unto the ends of it' teaches us that latitudes and longitudes on earth as well as the lengths of days and nights are determined

[108] Talmud Bavli, Qiddushin, 49b, trans. I. Epstein. Judah ha-Cohen quotes only a part of the Talmudical passage.

[109] Ed. Spiro, 5^{r}.

by the heavens, and that every strip of land has its own specific couterpart in the heavens.[110]

However, it is important to note that when compiling his encyclopedia Judah made no attempt to harmonize the divergent views that he encountered in his sources. It is clear that he let himself be guided by the source he considered the most useful for the particular scientific discipline he was dealing with at that particular moment, discarding other concepts of the structure of the earth for the time being. One illustration of this procedure is provided at the end of his survey of the *Parva Naturalia*. There he states that the inhabitants of warm and moist regions live longer than those of cold and dry ones and that inhabitants of islands also enjoy a long life,[111] confining himself to mentioning these facts in accordance with his source without bothering to relate them in any way to his views on the *oikoumene*, or to the effect of heat and cold on human life which he described in other parts of his encyclopedia. Likewise, when explaining a Talmudical story about Rava bar bar Hana he states that it may be inferred from Dt. 8:15 that the people of Israel dwelt in the great wilderness, which was situated along the equator, apparently forgetting that in the earlier meteorological section of his work he had held this region to be unfit for human life.[112]

VII. SHEMTOV IBN FALAQUERA'S *DE'OT HA-FILOSOFIM*

Falaquera's account of the *oikoumene*, which, like the earlier one by Judah ha-Cohen is to be found in the meteorological part of his encyclopedia, the *De'ot ha-Filosofim*, consists primarily of a combination of the two aforementioned commentaries by Ibn Rushd. However, unlike his predecessor, Falaquera did not epitomize these two commentaries, but, instead, inserted long quotations from them in his own work, moving from one commentary to the other when he deemed this necessary.

[110] *MḤ* Explanation of Biblical verses, ed. D. Goldstein, 'The commentary of Judah ben Solomon Hakohen ibn Matqa to Genesis, Psalms and Proverb', *Hebrew Union College Annual*, 52 (1981): 203-52, p. 216, lines 382-388.

[111] *MḤ*, MS Oxford Poc. 343, fol. 71^{r}.

[112] *MḤ*, Explanation of Biblical verses, ed. Goldstein, 'The commentary', p. 219, lines 473-4. The Talmudical passage Judah expounds in the preceding lines is to be found in Bava Batra, 74a.

Having introduced the subject by explaining that the earth can be divided into four quarters by two imaginary lines, Falaquera goes on to reproduce more or less verbatim Ibn Rushd's discussion in the Epitome of the *oikoumene* of the northern hemisphere and of the various opinions about the habitability of the equatorial zone, a section which he ends by noting: 'According to Ibn Sīnā, the opinion of the Peripatetics (on this issue) is contrary to the senses and to reason.'[113] He then proceeds to present Aristotle's view, for which he switches to the Middle Commentary. From this text he quotes some lines about the regions of the earth that are either too cold or too hot for habitation,[114] after which he turns to investigating the proofs for the uninhabitability of these regions, in particular that of the torrid zone. This investigation is also taken almost literally from the Middle Commentary, which, as we have said, was more elaborate than in the Epitome.[115] In doing so Ibn Falaquera thus reproduced Aristotle's defense of the uninhabitability of the equatorial zone.

What is noteworthy, however, is that Falaquera entirely omits the passage from the Middle Commentary in which Ibn Rushd says that Aristotle's commentators adopted a five-zones division of the earth with respect to habitability. As mentioned above, in this passage Ibn Rushd sought to provide an argument for Aristotle's alleged silence with respect to the uninhabitability of the southern hemisphere.[116] Towards the end of his discussion, Falaquera concludes that there are two symmetrical habitable zones as Aristotle had taught, which alters Ibn Rushd's conclusion in the Epitome.[117] This conclusion is fol-

[113] *DF* (MS Leiden, Univ. Library, Or, 4758) fol. 171^{r}, col. 2, lines 11-32 = *Jawāmi'*, pp. 44.9-45.12. Instead of 'northern' (*Jawāmi',* p. 44.16) Falaquera mistakenly has 'southern'.

[114] *DF*, fol. 171^{r}, col. 2, line 32 - fol. 171^{v}, col. 1, line 7 = *Talkhīṣ*, p. 111.1-7.

[115] *DF*, fol. 171^{v}, col. 1, line 7 - fol. 172^{r}, col. 1, line 7 largely corresponds to *Talkhīṣ*, pp. 112.5-115.11, although Ibn Falaquera slightly abridges his source. For example, where Ibn Rushd says that Aristotle employed an argument taken from his 'De Caelo' (cf. above, section V), Falaquera notes that he employed an argument taken 'from somewhere else'. He also omits the end of Ibn Rushd's discussion that elaborates on Aristotle's proofs (*Talkhīṣ*, pp. 116-18), thus omitting Ibn Rushd's observation that none of Aristotle's commentators noted that these proofs were implicit in the Aristotelian account (cf. above, section V).

[116] Cf. above, section V. The passage he omits corresponds to *Talkhīṣ* pp. 111.7-112.4, which comes directly after the statement that Aristotle held some regions to be either too cold or too hot for habitation, cf. note 114.

[117] *DF*, fol. 172^{r}, col. 1, lines 13-15 = *Jawāmi'*, p. 50.3-6. Cf. above, n. 62.

lowed by an explanation of how there can be more dry land than water in the northern hemisphere, an explanation that is again derived from the Epitome.[118]

It would thus appear that, in contradistinction to Judah ha-Cohen, Ibn Falaquera subscribed to the existence of a southern habitable zone without reservation. What is more, by simply disregarding the passage in the Middle Commentary which said that Aristotle did not refer to the habitability of the southern hemisphere, he advisedly smoothed away the discrepancy between the Epitome and the Middle Commentary with respect to this doctrine. He thus presented the thesis that the southern temperate zone is habitable as being the Aristotelian view, without mentioning the difference that Ibn Rushd observed between Aristotle's view as presented in the Arabic version of the *Meteorology* and that presented by the commentators. In all probability, Falaquera simply took it for granted that, according to Aristotle, a habitable zone in the southern hemisphere existed, and therefore deemed it unnecessary to dwell on the difference noted by Ibn Rushd in his Middle Commentary.

That Ibn Falaquera, too, was acquainted with various concepts of the *oikoumene* is clear from one of his other works *Sefer ha-mevaqqesh*, where in the section on astronomy he mentions the seven climes relating them to the seven planets.[119] In the same section, where the Seeker questions the astronomer on his science, this astronomer presents the following picture of the *oikoumene*: The earth is like an egg, half of which is immersed in water with the other half emerging from the water. Of the uncovered half, half is desolate (south of the equator), while the other half is inhabited (north of the equator). The equator is an imaginary line which goes from east to west. It lies under Aries and night and day are equal there. In the inhabited part there are seven seas. In each sea there are islands of various sizes and 15 smaller seas, all of which are like branches of the encompassing sea. Moreover, in this quarter 240 rivers and about 200 mountains are found. In this part there are seven *yishshuvim* that are called climes, stretching from east to west and these are ruled by 1000 kings.[120]

[118] *DF*, fol. 172^{r}, col. 1, lines 15-24, cf. *Jawāmi'*, p. 51.9-15.

[119] *Sefer ha-Mevaqqesh* (The Hague, 1772), pp. 82-3.

[120] *Ibid*., p. 83-4. I have paraphrased the contents of this passage, omitting the measures (in *parashot*) of the various seas, isles and climes provided by Ibn Falaquera. I wish to thank the reviewer of *Arabic Sciences and Philosophy* for directing my attention to this passage.

VIII. GERSHOM BEN SOLOMON'S *SHA'AR HA-SHAMAYIM*

Finally, mention should be made of the third encyclopedia produced in the thirteenth century, Gershom ben Solomon's *Sha'ar ha-Shamayim*.[121] In the section devoted to natural science we find a few casual remarks that relate to concepts of the *oikoumene*. In his discussion of plants, for example, Gershom says that the sugar-cane can grow only in the fourth climate and that grapes cannot grow in England, situated in the seventh clime.[122] In a later passage, he records the opinion to be found in a 'book of one of the later scholars' that spontaneous generation is possible along the equator. To this he adds that this author based himself on Ibn Sīnā who held that the air in that region was balanced, in which circumstances spontaneous generation is not impossible, although it seldom occurs.[123] It is noteworthy that Gershom did not include a systematic discussion of the *oikoumene* in the First Gate of his work, which deals with meteorological phenomena, given that he draws heavily on Ibn Tibbon's translation of the *Meteorology* in that Gate. However, a discussion of the *oikoumene* is found in the astronomical part (Gate Thirteen) of his work, which may indicate that, in Gershom ben Solomon's opinion, the subject fell under the heading of astronomy and not under that of natural philosophy. In any event, both the location of the subject as well as its treatment mark a departure from Aristotle's approach, since the division of the inhabited world adopted by Gershom is not the five-zones scheme but that of the seven climes. Gershom's treatment of the earth's habitability, which is not found in the printed editions of the *Sha'ar ha-Shamayim,*[124] focuses on the description of astronomical phenomena in the inhabited and uninhabited areas of the world, paying no attention to climatological and hardly any to geographical features. Besides dealing with the positions of the stars in the various areas, it also elaborates on the arctic

[121] Recent research has shown that Gershom compiled this work in the last quarter of the thirteenth century, cf. M. Zonta, 'Mineralogy, botany and zoology in medieval Hebrew encyclopaedias', *Arabic Sciences and Philosophy*, 6 (1996): 263-315, pp. 277-8.

[122] *Sha'ar ha-Shamayim*, ed. W. Heidenheim (Roedelheim, 1801), 15^{v}-16^{r}.

[123] *Ibid.*, 45a. This 'later scholar' was very probably Ibn Ṭufayl, cf. above n. 68.

[124] The following description is based on MS Oxford, Bodleian, Opp. 601 (Neubauer 1325), fols. 220^{r}-227^{r}. My thanks to Prof. M. Zonta for providing me with the relevant information on this manuscript.

regions where the sun does not set in summer or rise in winter. At the latitude of 67˚15´, which Gershom posits as the extreme end of the inhabited world, it remains day for one month in summer, whereas in the middle of the winter night reigns for a month. At latitudes of 69˚45´, 73˚30´ and 84˚ it remains night for two, three and five winter months respectively, whereas at the latitude of 90˚ the year consists of one day and one night, each lasting six months.[125] With respect to this phenomenon, the *Sha'ar ha-Shamayim* is more detailed than the other two encyclopedias.

The discussion of the *oikoumene* ends with the description of the seven climes that constitute the *oikoumene*.[126] Here Gershom states that the region along the equator itself is uninhabited, habitation first being found from about the middle of the first clime, that is to say, at about 16˚30´. Gershom records the latitude of the middle of each clime, its northern limit, the hours of sunlight at the longest day of the summer in the middle of the clime and at its northern limit, as well as the number of miles contained in it. To this he adds that his Arabic source also recorded the shadow 'in each and every clime', but that the Latin translation omitted this feature. According to Bodenheimer and Gross, this Arabic source was al-Farghānī.[127]

[125] MS Oxford, fols. 224^{r}-224^{v}.

[126] This section (fols. 225^{v}-227^{r}) ends in the middle of the description of the seventh clime.

[127] S. Bodenheimer, *The Gate of Heaven* (Jerusalem, 1953), pp. 47-8 notes that Gershom himself says that he largely followed al-Farghānī in his astronomy. Bodenheimer derived this piece of information from H. Gross, 'Zur Geschichte der Juden in Arles', *Monatsschrift für Geschichte und Wissenschaft des Judenthums,* 28 (1879): 228-38, pp. 233-4 who pointed out that Gershom's account is a literal excerpt from Anatoli's Hebrew translation of al-Farghānī's summary of the *Almagest*, with some additions from other sources. Incidentally, it is interesting to allude to another 13th-century text that deals with the seven climes, namely Abraham Halevi bar Ḥisdai's *Sefer Mishpat Shiv'ah ha-Aqlimim*, edited by M. Grosberg in *Sefer Yeẓirah* (London, 1903) on the basis of MS Oxford 2250. According to the copyist, this brief treatise, which consists of only two pages, was found at the end of *Sefer ha-Tapuaḥ*, and translated from Arabic into Hebrew. Although the word *Aqlimim* indeed suggests an Arabic source, the text contains a number of foreign words such as 'otzidente', 'otzeane', 'oriente', 'settentrione' suggesting that a Latin or vernacular source had also been influential. The occurrence of Latin geographical names as, for example, Ethiopia, India, Alexandria, corroborates this assumption. The seven-climes scheme itself follows the pattern of those of al-Battānī, al-Farghānī and al-Bīrūnī, differing from them as regards the minutes and as regards the latitude of the second clime (23°16´ instead of 24°06´, although this may be a printing error). The author gives detailed information as to the regions comprised by each of the climes, Jerusalem and the Galilee being situated in the fourth. However, he says nothing on the borders of the *oikoumene* and on the various regions of temperature of the earth.

In sum: it can be concluded that medieval Jewish authors were acquainted with a variety of theories on the earth's habitability. We found several divisions or schemes of the *oikoumene* in their writings: a tripartite division in which a single habitable zone was bordered by two uninhabitable ones; the seven-clime scheme; a division into five zones and the idea of a quadrate division of the global surface, depending on the discipline or intellectual tradition whithin which they were discussed. More often than not these notions were combined or coexisted. Of the Hebrew scientific texts examined here, the *MḤ* offers the most extensive information on the contemporary debate on the *oikoumene*. Moreover, the *MḤ* differs from the other two in that its author does not limit himself to quoting his sources, but also, albeit hesitatingly, presents his own opinion, and in that he criticizes the authority whose views he is summarizing. In contrast, the *DF* does not criticize the sources on which it draws, but its author can be shown to have intermingled his sources in order to remove discrepancies he encountered in them.